

What is claimed is:

1. A method of fabricating a gallium nitride microelectronic layer comprising the steps of:
 - converting a surface of a (111) silicon layer to 3C-silicon carbide;
 - epitaxially growing a layer of 3C-silicon carbide on the converted surface of
 - 5 the (111) silicon layer;
 - growing a layer of 2H-gallium nitride on the epitaxially grown layer of 3C-silicon carbide; and
 - laterally growing the layer of 2H-gallium nitride to produce the gallium nitride microelectronic layer.
2. A method according to Claim 1 wherein the silicon layer is a (111) silicon substrate and wherein the converting step comprises the step of:
 - converting a surface of the (111) silicon substrate to 3C-silicon carbide.
3. A method according to Claim 1 wherein the step of converting is preceded by the step of:
 - implanting oxygen into a (111) silicon substrate to define the (111) layer on the (111) silicon substrate.
4. A method according to Claim 1 wherein the step of converting is preceded by the steps of:
 - bonding a (111) silicon layer to a substrate.
5. A method according to Claim 1 wherein the step of converting comprises the step of chemically reacting the surface of the (111) silicon layer with a carbon containing precursor to convert the surface of the (111) silicon layer to 3C-silicon carbide.
6. A method according to Claim 1 wherein the step of eptiaxially growing is followed by the step of thinning the epitaxially grown layer of 3C-silicon carbide.

7. A method according to Claim 1 wherein the step of growing is preceded by the step of growing an aluminum nitride and/or gallium nitride layer on the epitaxially grown layer of 3C-silicon carbide, and wherein the step of growing comprises the step of:

5 growing a layer of 2H-gallium nitride on the buffer layer, opposite the epitaxially grown layer of 3C-silicon carbide.

8. A method according to Claim 1 wherein the step of laterally growing comprises the steps of:

forming a mask on the layer of 2H-gallium nitride, the mask including at least one opening that exposes the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride through the at least one opening and onto the mask.

9. A method according to Claim 1 wherein the step of laterally growing comprises the steps of:

forming at least one trench in the layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride from the at least one sidewall.

10. A method according to Claim 1 wherein the step of laterally growing comprises the steps of:

forming at least one post in the layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride from the at least one sidewall.

11. A method of fabricating a gallium nitride microelectronic layer comprising the steps of:

converting a surface of a (111) silicon substrate to 3C-silicon carbide;

epitaxially growing a layer of 3C-silicon carbide on the converted surface of

5 the (111) silicon substrate;

growing a buffer layer on the epitaxially grown layer of 3C-silicon carbide;

growing a layer of 2H-gallium nitride on the buffer layer; and
laterally growing the layer of 2H-gallium nitride to produce the gallium
nitride microelectronic layer.

12. A method according to Claim 11 wherein the step of converting
comprises the step of chemically reacting the surface of the (111) silicon substrate
with a carbon containing precursor to convert the surface of the (111) silicon
substrate to 3C-silicon carbide.

13. A method according to Claim 11 wherein the step of laterally growing
comprises the steps of:

forming a mask on the layer of 2H-gallium nitride, the mask including at least
one opening that exposes the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride through the at least one
opening and onto the mask.

14. A method according to Claim 11 wherein the step of laterally growing
comprises the steps of:

forming at least one trench in the layer of 2H-gallium nitride that defines at
least one sidewall in the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride from the at least one
sidewall.

15. A method according to Claim 11 wherein the step of laterally growing
comprises the steps of:

forming at least one post in the layer of 2H-gallium nitride that defines at least
one sidewall in the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride from the at least one
sidewall.

16. A method of fabricating a gallium nitride microelectronic layer
comprising the steps of:

implanting oxygen into a (111) silicon substrate to define a (111) silicon
surface layer on the (111) silicon substrate;

- 5 converting at least a portion of the (111) silicon surface layer to 3C-silicon carbide;
 epitaxially growing a layer of 3C-silicon carbide on the converted (111) silicon surface layer;
 growing a buffer layer on the epitaxially grown layer of 3C-silicon carbide;
10 growing a layer of 2H-gallium nitride on the buffer layer; and
 laterally growing the layer of 2H-gallium nitride to produce the gallium nitride microelectronic layer.

17. A method according to Claim 16 wherein the converting step comprises the step of converting the entire (111) silicon surface layer to 3C-silicon carbide.

18. A method according to Claim 16 wherein the step of converting comprises the step of chemically reacting the (111) silicon surface layer with a carbon containing precursor to convert at least a portion of the (111) silicon surface layer to 3C-silicon carbide.

19. A method according to Claim 16 wherein the step of laterally growing comprises the steps of:

 forming a mask on the layer of 2H-gallium nitride, the mask including at least one opening that exposes the layer of 2H-gallium nitride; and

- 5 laterally growing the layer of 2H-gallium nitride through the at least one opening and onto the mask.

20. A method according to Claim 16 wherein the step of laterally growing comprises the steps of:

 forming at least one trench in the layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride; and

- 5 laterally growing the layer of 2H-gallium nitride from the at least one sidewall.

21. A method according to Claim 16 wherein the step of laterally growing comprises the steps of:

forming at least one post in the layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride from the at least one sidewall.

22. A method of fabricating a gallium nitride microelectronic layer comprising the steps of:

bonding a (111) silicon substrate to a (100) silicon substrate;

thinning the (111) silicon substrate to define a (111) silicon layer on the (100)
5 silicon substrate;

converting at least a portion of the (111) silicon layer to 3C-silicon carbide;

epitaxially growing a layer of 3C-silicon carbide on the converted (111)
silicon layer;

growing a buffer nitride layer on the epitaxially grown layer of 3C-silicon
10 carbide;

growing a layer of 2H-gallium nitride on the buffer layer; and

laterally growing the layer of 2H-gallium nitride to produce the gallium
nitride microelectronic layer.

23. A method according to Claim 22 wherein the converting step comprises the step of:

converting the entire (111) silicon layer to 3C-silicon carbide.

24. A method according to Claim 22 further comprising the step of:

forming microelectronic devices in the (100) silicon substrate.

25. A method according to Claim 22 further comprising the steps of:

removing a portion of the 3C-silicon carbide layer, the gallium nitride layer
and the gallium nitride microelectronic layer to expose a portion of the (100) silicon
substrate; and

5 fabricating microelectronic devices in the exposed portion of the (100) silicon substrate.

26. A method according to Claim 22 wherein the step of converting comprises the step of chemically reacting the surface of the (111) silicon layer with a carbon containing precursor to convert at least a portion of the (111) silicon layer to 3C-silicon carbide.

27. A method according to Claim 22 wherein the step of laterally growing comprises the steps of:

forming a mask on the layer of 2H-gallium nitride, the mask including at least one opening that exposes the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride through the at least one opening and onto the mask.

28. A method according to Claim 22 wherein the step of laterally growing comprises the steps of:

forming at least one trench in the layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride from the at least one sidewall.

29. A method according to Claim 22 wherein the step of laterally growing comprises the steps of:

forming at least one post in the layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride; and

5 laterally growing the layer of 2H-gallium nitride from the at least one sidewall.

30. A method according to Claim 25 wherein the step of fabricating comprises the steps of:

epitaxially growing a silicon layer on the exposed portion of the (100) silicon substrate; and

5 fabricating the microelectronic devices in the epitaxially grown silicon layer.

31. A method according to Claim 30 wherein the step of epitaxially growing is preceded by the step of capping the gallium nitride microelectronic layer.

32. A gallium nitride microelectronic structure comprising:
a (111) silicon layer;
a 3C-silicon carbide layer on the (111) silicon layer;
an underlying layer of 2H-gallium nitride on the 3C-silicon carbide layer; and
5 a lateral layer of 2H-gallium nitride on the underlying layer of 2H-gallium nitride.

33. A gallium nitride microelectronic structure according to Claim 32 wherein the (111) silicon layer comprises a surface of a (111) silicon substrate.

34. A gallium nitride microelectronic structure according to Claim 32 wherein the (111) silicon layer comprises a surface of a (111) silicon SIMOX substrate.

35. A gallium nitride microelectronic structure according to Claim 32 wherein the (111) silicon layer comprises a surface of a (111) Silicon-On-Insulator (SOI) substrate.

36. A gallium nitride microelectronic structure according to Claim 32 further comprising:
a buffer layer between the a 3C-silicon carbide layer and the underlying layer of 2H-gallium nitride.

37. A gallium nitride microelectronic structure according to Claim 32 further comprising:
a mask on the underlying layer of 2H-gallium nitride, the mask including at least one opening that exposes the underlying layer of 2H-gallium nitride;
5 wherein the lateral layer of 2H-gallium nitride extends through the at least one opening and onto the mask.

38. A gallium nitride microelectronic structure according to Claim 32 further comprising:

at least one trench in the layer of 2H-gallium nitride that defines at least one sidewall in the underlying layer of 2H-gallium nitride;

5 wherein the lateral layer of 2H-gallium nitride extends from the at least one sidewall.

39. A gallium nitride microelectronic structure according to Claim 32 further comprising:

at least one post in the layer of 2H-gallium nitride that defines at least one sidewall in the underlying layer of 2H-gallium nitride;

5 wherein the lateral layer of 2H-gallium nitride extends from the at least one sidewall.

40. A gallium nitride microelectronic structure comprising:

a (111) silicon substrate;

a 3C-silicon carbide layer on the (111) silicon substrate;

a buffer layer on the 3C-silicon carbide layer;

5 an underlying layer of 2H-gallium nitride on the buffer layer; and

a lateral layer of 2H-gallium nitride on the underlying layer of 2H-gallium nitride.

41. A gallium nitride microelectronic structure according to Claim 40 further comprising:

a mask on the underlying layer of 2H-gallium nitride, the mask including at least one opening that exposes the underlying layer of 2H-gallium nitride;

5 wherein the lateral layer of 2H-gallium nitride extends through the at least one opening and onto the mask.

42. A gallium nitride microelectronic structure according to Claim 40 further comprising:

at least one trench in the underlying layer of 2H-gallium nitride that defines at least one sidewall in the underlying layer of 2H-gallium nitride;

5 wherein the lateral layer of 2H-gallium nitride extends from the at least one sidewall.

43. A gallium nitride microelectronic structure according to Claim 40 further comprising:

at least one post in the underlying layer of 2H-gallium nitride that defines at least one sidewall in the underlying layer of 2H-gallium nitride;

5 wherein the lateral layer of 2H-gallium nitride extends from the at least one sidewall.

44. A gallium nitride microelectronic structure comprising:

a (111) silicon substrate;

a silicon dioxide layer on the (111) silicon substrate;

a 3C-silicon carbide layer on the silicon dioxide layer;

5 a buffer layer on the 3C-silicon carbide layer;

an underlying layer of 2H-gallium nitride on the buffer layer; and

a lateral layer of 2H-gallium nitride on the underlying layer of 2H-gallium nitride.

45. A gallium nitride microelectronic structure according to Claim 44 further comprising:

a layer of (111) silicon between the silicon dioxide layer and the 3C-silicon carbide layer.

46. A gallium nitride microelectronic structure according to Claim 44 further comprising:

a mask on the underlying layer of 2H-gallium nitride, the mask including at least one opening that exposes the underlying layer of 2H-gallium nitride;

5 wherein the lateral layer of 2H-gallium nitride extends through the at least one opening and onto the mask.

47. A gallium nitride microelectronic structure according to Claim 44 further comprising:

at least one trench in the underlying layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride;

5 wherein the lateral layer of 2H-gallium nitride extends from the at least one sidewall.

48. A gallium nitride microelectronic structure according to Claim 44 further comprising:

at least one post in the underlying layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride;

5 wherein the lateral layer of 2H-gallium nitride extends from the at least one sidewall.

49. A gallium nitride microelectronic structure comprising:

a (100) silicon substrate;

an insulating layer on the (100) silicon substrate;

a 3C-silicon carbide layer on the insulating layer;

5 a buffer layer on the 3C-silicon carbide layer;

an underlying layer of 2H-gallium nitride on the buffer layer; and

a lateral layer of 2H-gallium nitride on the underlying layer of 2H-gallium nitride.

50. A gallium nitride microelectronic structure according to Claim 49 further comprising:

a plurality of microelectronic devices in the (100) silicon substrate.

51. A gallium nitride microelectronic structure according to Claim 50 wherein the 3C-silicon carbide layer, the underlying layer of 2H-gallium nitride and the lateral layer of 2H-gallium nitride comprise a respective 3C-silicon carbide

pedestal, a pedestal of underlying 2H-gallium nitride and a pedestal of lateral 2H-gallium nitride that expose the plurality of microelectronic devices in the (100) silicon substrate.

52. A gallium nitride microelectronic structure according to Claim 49 further comprising:

a (100) silicon layer on the (100) silicon substrate; and

a plurality of microelectronic devices in the (100) silicon layer.

53. A gallium nitride microelectronic structure according to Claim 53 wherein the 3C-silicon carbide layer, the underlying layer of 2H-gallium nitride and the lateral layer of 2H-gallium nitride comprise a respective 3C-silicon carbide pedestal, a pedestal of underlying 2H-gallium nitride and a pedestal of lateral 2H-gallium nitride; and

wherein the (100) silicon layer is on the (100) silicon substrate adjacent the pedestal.

54. A gallium nitride microelectronic structure according to Claim 54 further comprising a capping layer on the pedestal, and extending between the pedestal and the (100) silicon layer.

55. A gallium nitride microelectronic structure according to Claim 49 further comprising:
a layer of (111) silicon between the insulating layer and the 3C-silicon carbide layer.

56. A gallium nitride microelectronic structure according to Claim 49 further comprising:
a mask on the underlying layer of 2H-gallium nitride, the mask including at least one opening that exposes the underlying layer of 2H-gallium nitride;
wherein the lateral layer of 2H-gallium nitride extends through the at least one opening and onto the mask.

57. A gallium nitride microelectronic structure according to Claim 49 further comprising:
at least one trench in the underlying layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride;
wherein the lateral layer of 2H-gallium nitride extends from the at least one sidewall.

58. A gallium nitride microelectronic structure according to Claim 49 further comprising:

at least one post in the underlying layer of 2H-gallium nitride that defines at least one sidewall in the underlying layer of 2H-gallium nitride;

- 5 wherein the lateral layer of 2H-gallium nitride extends from the at least one sidewall.

59. A method of fabricating a gallium nitride microelectronic layer comprising the steps of:

 epitaxially growing a layer of 3C-silicon carbide on a surface of a (111) silicon layer;

- 5 growing a layer of 2H-gallium nitride on the epitaxially grown layer of 3C-silicon carbide; and

 laterally growing the layer of 2H-gallium nitride to produce the gallium nitride microelectronic layer.

60. A method according to Claim 59 wherein the silicon layer is a (111) silicon substrate.

61. A method according to Claim 59 wherein the step of epitaxially growing is preceded by the step of:

 implanting oxygen into a (111) silicon substrate to define the (111) layer on the (111) silicon substrate.

62. A method according to Claim 59 wherein the step of epitaxially growing is preceded by the step of:

 bonding a (111) silicon layer to a substrate.

63. A method according to Claim 59 wherein the step of eptiaxially growing is followed by the step of thinning the epitaxially grown layer of 3C-silicon carbide.

64. A method according to Claim 59 wherein the step of growing is preceded by the step of growing an aluminum nitride and/or gallium nitride layer on the epitaxially grown layer of 3C-silicon carbide, and wherein the step of growing comprises the step of:

- 5 growing a layer of 2H-gallium nitride on the buffer layer, opposite the epitaxially grown layer of 3C-silicon carbide.

65. A method according to Claim 59 wherein the step of laterally growing comprises the steps of:

forming a mask on the layer of 2H-gallium nitride, the mask including at least one opening that exposes the layer of 2H-gallium nitride; and

- 5 laterally growing the layer of 2H-gallium nitride through the at least one opening and onto the mask.

66. A method according to Claim 59 wherein the step of laterally growing comprises the steps of:

forming at least one trench in the layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride; and

- 5 laterally growing the layer of 2H-gallium nitride from the at least one sidewall.

67. A method according to Claim 1 wherein the step of laterally growing comprises the steps of:

forming at least one post in the layer of 2H-gallium nitride that defines at least one sidewall in the layer of 2H-gallium nitride; and

- 5 laterally growing the layer of 2H-gallium nitride from the at least one sidewall.